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SOLAR/1002-79/01

Monthly Performance Report

WASHINGTON NATURAL GAS

JANUARY 1979



U.S. Department of Energy

National Solar Heating and
Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT
WASHINGTON NATURAL GAS COMPANY
JANUARY 1979

I. SYSTEM DESCRIPTION

The Washington Natural Gas Company site is a single-family residence in Kirkland, Washington. The home has approximately 2607 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 591 square feet. The array faces south at an angle of 57 degrees to the horizontal. Air is the transfer medium that delivers solar energy from the collector array to storage and to the space heating and hot water loads. Solar energy is stored underground in a 273-cubic-foot bin containing 27,300 pounds of smooth stones. The bin has two inches of styrofoam insulation. Preheated city water is stored in an 80-gallon preheat storage tank and supplied, on demand, to a conventional 50-gallon DHW tank. When solar energy is insufficient to satisfy the space heating load, a gas furnace provides auxiliary energy for space heating. Similarly, a gas-fired unit in the DHW tank provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has four modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when there is no demand for space heating, and the temperature of the collector outlet exceeds that of the solar energy storage bin as measured by the control system sensors. Air circulates from the collector, through the air-to-liquid heat exchanger, through the air-handling unit and then through the solar energy storage bin to the collector. This mode exists as long as the temperature of the storage bin does not exceed 140°F.

Mode 2 - Storage-to-Space Heating: This mode activates when space heating is required, the solar insolation is insufficient to furnish the required energy from the collector, and the temperature of the solar energy storage bin is higher than 90°F, as indicated by the control system sensors. Air circulates from the solar energy storage bin, through the air-handling unit and gas furnace, then returns to the storage bin, bypassing the collectors.

Mode 3 - Collector-to-DHW Tank: This mode activates during the summer when the collector outlet temperature is higher than the temperature of the water in the preheat tank as indicated by the control system sensors. Air circulates from the collector, through the air-to-liquid heat exchanger and the air-handling unit, and returns to the collectors, bypassing the solar energy storage bin. Domestic water preheating also occurs in modes 1 and 4.

Mode 4 - Collector-to-Space Heating: This mode activates when the collector is operating, and the plenum temperature at the top of storage as indicated by the control system sensors is higher than the minimum value suitable for supplying heat to the house. Heated air is circulated through the house by the air-handling unit before being returned to the collector.

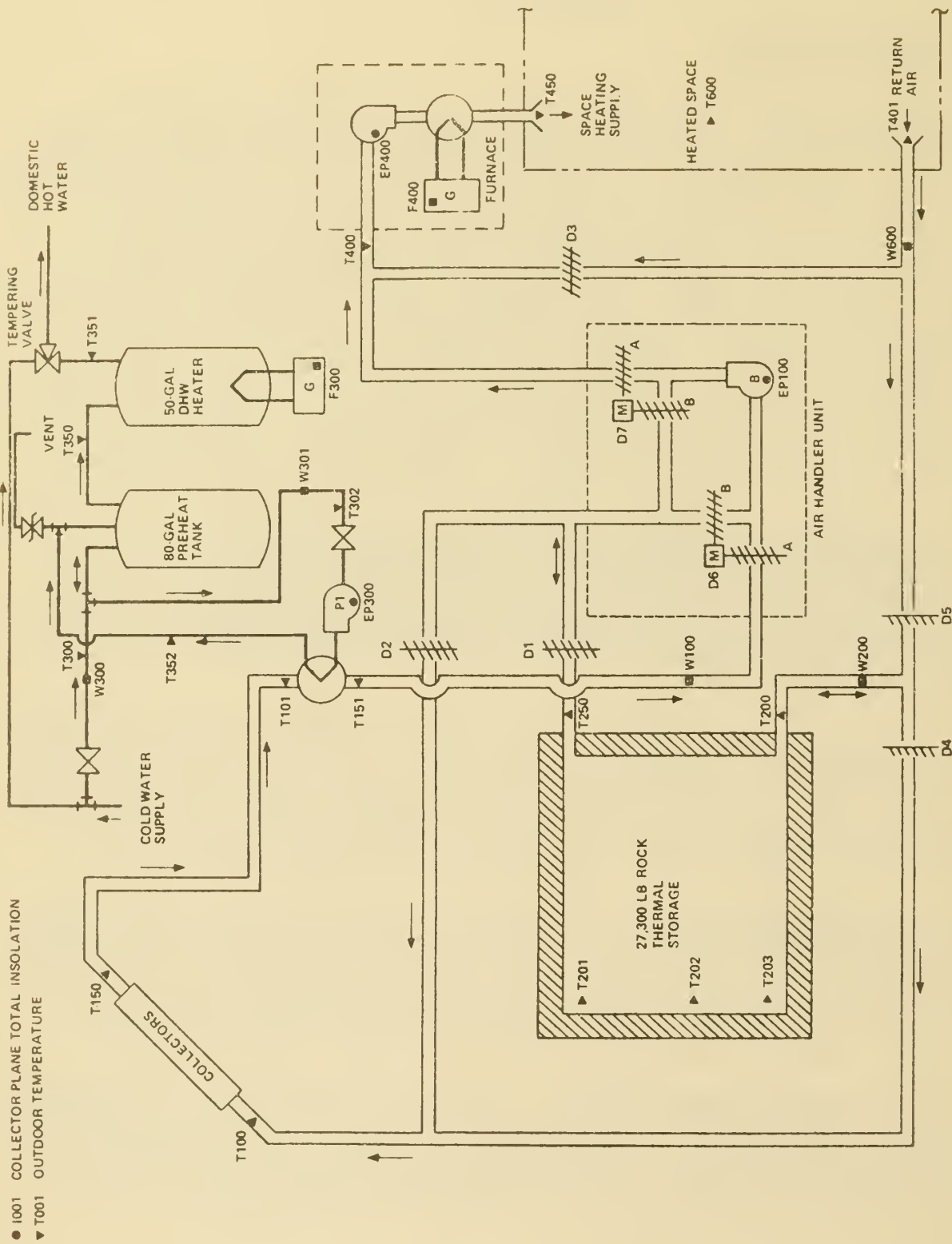


Figure 1. WASHINGTON NATURAL GAS SOLAR ENERGY SYSTEM SCHEMATIC

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was occupied and the solar energy system was operational for the entire month of January. Boeing was at the site between January 8 and January 11 conducting an air-mapping survey. The total collected solar energy was 3.6 million Btu with 0.37 million Btu consumed by the DHW subsystem and 0.78 million Btu consumed by the space heating subsystem. The amount of energy lost from storage was 1.3 million Btu.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 10.8 million Btu for a daily average of 591 Btu per square foot. This was above the estimated average daily solar radiation for this geographical area during January of 465 Btu per square foot for a south-facing plane with a tilt of 57 degrees to the horizontal. The average ambient temperature during January was 36°F as compared with the long-term average for January of 38°F. The number of heating degree-days for the month (based on a 65°F reference) was 906, as compared with the long-term average of 831.

THERMAL PERFORMANCE

System - During January the solar energy system performed somewhat poorer than expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 3.6 million Btu versus an estimated 1.3 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 1.2 million Btu. System total solar fraction was 11 percent versus an estimated 25 percent.

Collector - The total incident solar radiation on the collector array for the month of January was 10.8 million Btu. During the period the collector loop was operating the total insolation amounted to 8.6 million Btu. The total collected solar energy for the month of January was 3.6 million Btu, resulting in a collector array efficiency of 33 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 2.2 million Btu. Operating energy required by the collector loop was 0.61 million Btu.

Storage - Solar energy delivered to storage was 2.2 million Btu. There were 0.73 million Btu delivered from storage to the space heating subsystem. Energy loss from storage was 1.3 million Btu. This loss represented 60 percent of the energy delivered to storage. The storage efficiency was 40 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 73°F.

DHW Load - The DHW subsystem consumed 0.37 million Btu of solar energy and 2.1 million Btu of auxiliary fossil fuel energy to satisfy a hot water load of 1.6 million Btu. The solar fraction of this load was 23 percent. Losses from the DHW subsystem were 0.84 million Btu. The DHW subsystem consumed a total of 0.02 million Btu of operational energy, resulting in an electrical energy expense of 0.02 million Btu. A daily average of 59 gallons of DHW was consumed at an average temperature of 150°F delivered from the tank.

Space Heating Load - The space heating subsystem consumed 0.78 million Btu of solar energy and 15.2 million Btu of auxiliary fossil fuel energy to satisfy a space heating load of 10.0 million Btu. The solar fraction of this load was 9 percent. Losses from the space heating subsystem were 6.0 million Btu. The space heating subsystem consumed a total of 0.52 million Btu of operational energy, resulting in fossil fuel energy savings of 1.5 million Btu.

OBSERVATIONS

Boeing has completed the air-mapping survey and has identified the relationships between the flow as measured by the sensors and the flow at various parts of the system as a function of mode. These relationships will be used in future analysis of this site.

There were days when the rock storage temperature was less than the return air temperature and caused auxiliary energy to be sent to storage. This system does not provide for a storage bypass when heating from the auxiliary source.

ENERGY SAVINGS

The solar energy system provided a total fossil fuel energy savings of 2.1 million Btu. The DHW subsystem provided a fossil fuel energy savings of 0.62 million Btu. The space heating subsystem contributed a fossil fuel energy savings of 1.5 million Btu.

III. ACTION STATUS

No action is planned at this time.

SOLAR HEATING AND COCLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SOLAR/1002-79/01

SITE/SYSTEM DESCRIPTION:

THE WASHINGTON NATURAL GAS SOLAR HEATING SYSTEM PROVIDES SPACE HEATING AND HOT WATER. AUXILIARY ENERGY IS SUPPLIED BY A FURNACE FOR SPACE HEATING AND BY A GAS WATER HEATER FOR HOT WATER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY
10.834 MILLION BTU
18332 BTU/SQ.FT.
3.589 MILLION BTU
6073 BTU/SQ.FT.
36 DEGREES F
70 DEGREES F
0.12 MI--IN BTU
0.614 MILLION BTU
0.540 MILLION BTU
20.908 MILLION BTU

COLLECTED SOLAR ENERGY

AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECSS SOLAR CONVERSION EFFICIENCY
ECSS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.637	10.017	N.A.	11.523 MILLION BTU
SOLAR FRACTION	23	9	N.A.	11 PERCENT
SOLAR ENERGY USED	0.374	0.778	N.A.	1.247 MILLION BTU
OPERATING ENERGY	0.022	0.518	N.A.	0.540 MILLION BTU
AUX. THERMAL ENERGY	1.263	9.145	N.A.	10.276 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FCSSI- FUEL	2.104	15.242	N.A.	17.126 MI--IN BTU
ELECTRICAL SAVINGS	-0.022	0.000	N.A.	-0.636 MILLION BTU
FOSSIL SAVINGS	0.623	1.454	N.A.	2.078 MILLION BTU

SYSTEM PERFORMANCE FACTOR:

0.609

DENOTES UNAVAILABLE DATA

@ DENOTES NULL DATA

N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SOLAR/1002-79/01

SITE/SYSTEM DESCRIPTION:

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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY
11.430 GIGA JOULES
208175 KJ/SQ.M.
3.786 GIGA JOULES
68964 KJ/SQ.M.
2 DEGREES C
21 DEGREES C
0.12
0.648 GIGA JOULES
0.570 GIGA JOULES
22.058 GIGA JOULES

COLLECTED SOLAR ENERGY

AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECSS SOLAR CONVERSION EFFICIENCY
ECSS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.727	10.568	N.A.	12.157 GIGA JOULES
SOLAR FRACTION	23	9	N.A.	11 PERCENT
SOLAR ENERGY USED	0.394	0.821	N.A.	1.316 GIGA JOULES
OPERATING ENERGY	0.023	0.546	N.A.	0.570 GIGA JOULES
AUX. THERMAL ENG	1.332	9.648	N.A.	10.841 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	2.220	16.080	N.A.	18.068 GIGA JOULES
ELECTRICAL SAVINGS	-0.023	0.000	N.A.	-0.671 GIGA JOULES
FOSSIL SAVINGS	0.657	1.534	N.A.	2.193 GIGA JOULES
SYSTEM PERFORMANCE FACTOR:		0.609		

- * DENOTES UNAVAILABLE DATA
- @ DENOTES NULL DATA
- N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SOLAR/1002-79/01

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.070	24	*	NOT	0.030	NOT	*
2	0.098	28	*	NOT	0.025	NOT	*
3	0.132	31	*	NOT	0.025	NOT	*
4	0.811	33	0.048	NOT	0.028	NOT	0.059
5	0.830	31	0.091	NOT	0.029	NOT	0.110
6	0.815	34	0.110	NOT	0.023	NOT	0.135
7	0.576	36	0.124	NOT	0.022	NOT	0.216
8	0.635	37	0.062	NOT	0.022	NOT	0.097
9	0.113	38	0.082	NOT	0.022	NOT	0.728
10	0.002	37	-0.030	NOT	0.026	NOT	16.351
11	0.023	40	-0.034	NOT	0.024	NOT	-1.495
12	0.007	41	-0.002	NOT	0.013	NOT	-0.315
13	0.681	40	0.025	NOT	0.019	NOT	0.037
14	0.023	37	0.101	NOT	0.014	NOT	4.315
15	0.109	36	-0.011	NOT	0.014	NOT	-0.098
16	0.068	38	-0.028	NOT	0.016	NOT	-0.412
17	0.769	39	-0.008	NOT	0.022	NOT	-0.011
18	0.723	37	0.086	NOT	0.019	NOT	0.119
19	0.005	42	0.078	NOT	0.009	NOT	14.321
20	0.071	46	0.020	NOT	0.008	NOT	0.281
21	0.303	40	0.019	NOT	0.013	NOT	0.062
22	0.240	37	0.032	NOT	0.016	NOT	0.134
23	0.185	38	-0.002	NOT	0.015	NOT	-0.009
24	0.297	37	0.024	NOT	0.015	NOT	0.081
25	0.246	34	0.031	NOT	0.018	NOT	0.125
26	0.029	34	-0.016	NOT	0.017	NOT	-0.555
27	0.102	37	-0.021	NOT	0.015	NOT	-0.205
28	0.406	32	0.034	NOT	0.019	NOT	0.085
29	0.787	32	*	NOT	0.027	NOT	*
30	0.866	32	0.121	NOT	0.024	NOT	0.140
31	0.811	30	0.150	NOT	0.025	NOT	0.184
SUM	10.834	-	1.247	N.A.	0.614	N.A.	-
AVG	0.349	36	0.040	N.A.	0.020	N.A.	0.115
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT COLLECTOR ARRAY PERFORMANCE

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979
SOLAR/1002-79/01

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.070	0.000	*	28	*
2	0.098	0.000	*	31	*
3	0.132	0.000	*	*	*
4	0.811	0.649	0.184	38	0.227
5	0.830	0.784	0.257	37	0.309
6	0.815	0.525	0.253	40	0.311
7	0.576	0.592	0.177	42	0.306
8	0.635	0.083	0.202	42	0.318
9	0.113	0.005	0.025	39	0.223
10	0.002	0.002	0.000	*	0.000
11	0.023	0.000	-0.000	40	-0.002
12	0.007	0.000	0.000	42	0.000
13	0.681	0.627	0.261	43	0.384
14	0.023	0.000	0.000	39	0.000
15	0.109	0.000	0.000	37	0.000
16	0.068	0.004	0.002	40	0.034
17	0.769	0.716	0.294	44	0.383
18	0.723	0.663	0.257	39	0.355
19	0.005	0.000	0.000	42	0.000
20	0.071	0.000	0.000	50	0.000
21	0.303	0.195	0.079	40	0.261
22	0.240	0.066	0.030	39	0.126
23	0.185	0.071	0.028	41	0.150
24	0.297	0.180	0.077	40	0.260
25	0.246	0.157	0.064	38	0.260
26	0.029	0.000	0.000	35	0.000
27	0.102	0.007	0.003	38	0.031
28	0.406	0.295	0.125	33	0.308
29	0.787	0.735	0.307	36	0.390
30	0.866	0.780	0.327	36	0.378
31	0.811	0.712	0.289	34	0.356
SUM	10.834	8.628	3.589	-	-
AVG	0.349	0.278	0.116	39	0.331
NBSID	0001		0100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT STORAGE PERFORMANCE

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SOLAR/1002-79/01

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	*	*	0.008	66	*
2	*	*	0.007	66	*
3	*	*	0.005	68	*
4	0.093	0.014	0.040	75	0.579
5	0.179	0.050	0.064	81	0.641
6	0.177	0.065	0.034	86	0.559
7	0.116	0.090	-0.066	84	0.213
8	0.154	0.048	0.047	83	0.616
9	0.005	0.060	-0.119	76	-12.300
10	-0.010	-0.021	-0.008	67	3.001
11	0.000	-0.037	0.011	68	1.000
12	0.000	-0.007	-0.013	67	1.000
13	0.161	0.012	-0.128	79	0.873
14	0.000	0.072	-0.132	74	1.000
15	0.000	-0.016	-0.004	65	1.000
16	0.001	-0.031	0.006	65	-39.722
17	0.177	-0.024	0.164	82	0.792
18	0.162	0.065	-0.003	93	0.384
19	0.000	0.078	-0.126	82	1.000
20	0.000	0.020	-0.037	68	1.000
21	0.050	0.019	-0.011	68	0.594
22	0.003	-0.003	-0.020	64	-7.037
23	0.007	-0.017	0.000	64	-2.417
24	0.038	0.011	0.013	66	0.606
25	0.031	0.011	-0.012	66	-0.032
26	0.000	-0.030	0.003	64	1.000
27	0.001	-0.027	0.002	65	-24.929
28	0.066	0.021	0.018	69	0.590
29	0.189	0.031	0.110	80	0.746
30	0.209	0.097	0.030	87	0.610
31	0.182	0.112	-0.011	88	0.556
SJM	2.203	0.735	0.149	-	-
AVG	0.071	0.024	0.005	73	0.401
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.

@ DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.018	42	0.004	0.000	0.014		0.023	-0.000	0.006	47	150	18
2	0.104	20	0.009	0.000	0.094		0.157	-0.000	0.016	44	150	130
3	0.080	7	0.004	0.000	0.076		0.126	-0.000	0.006	43	154	80
4	0.051	5	0.003	0.001	0.048		0.080	-0.001	0.005	44	149	62
5	0.067	30	0.030	0.002	0.037		0.062	-0.002	0.050	44	150	73
6	0.057	45	0.030	0.002	0.027		0.045	-0.002	0.050	44	148	68
7	0.075	42	0.025	0.001	0.049		0.082	-0.001	0.042	44	155	82
8	0.019	37	0.009	0.001	0.010		0.017	-0.001	0.015	46	147	22
9	0.007	39	0.002	0.001	0.005		0.008	-0.001	0.004	46	148	8
10	0.003	38	0.001	0.001	0.003		0.004	-0.001	0.001	44	142	4
11	0.022	32	0.005	0.000	0.017		0.029	-0.000	0.008	50	144	27
12	0.036	23	0.005	0.000	0.031		0.052	-0.000	0.008	44	150	37
13	0.031	18	0.007	0.001	0.024		0.040	-0.001	0.011	45	153	35
14	0.087	33	0.029	0.000	0.057		0.095	-0.000	0.049	45	152	99
15	0.066	15	0.005	0.000	0.061		0.102	-0.000	0.008	44	163	70
16	0.069	15	0.003	0.000	0.065		0.109	-0.000	0.005	43	155	75
17	0.029	12	0.009	0.002	0.020		0.033	-0.002	0.015	47	146	34
18	0.029	34	0.014	0.002	0.015		0.025	-0.002	0.024	50	145	34
19	0.000	0	0.000	0.000	0.000		0.000	-0.000	0.000	53	142	0
20	0.000	0	0.000	0.000	0.000		0.000	-0.000	0.000	53	142	0
21	0.094	36	0.032	0.001	0.062		0.104	-0.001	0.053	43	149	109
22	0.056	25	0.011	0.000	0.045		0.075	-0.000	0.019	48	147	58
23	0.081	18	0.013	0.001	0.067		0.112	-0.001	0.022	45	150	94
24	0.073	22	0.017	0.000	0.056		0.094	-0.000	0.028	44	157	87
25	0.066	22	0.014	0.000	0.052		0.087	-0.000	0.023	44	158	72
26	0.084	11	0.006	0.000	0.078		0.130	-0.000	0.010	44	156	83
27	0.137	7	0.013	0.001	0.124		0.207	-0.001	0.022	43	160	146
28	*	*	*	0.002	*		*	-0.002	*	*	*	*
29	0.065	33	0.024	0.002	0.041		0.068	-0.002	0.040	48	152	70
30	0.080	41	0.037	0.002	0.042		0.070	-0.002	0.062	43	151	84
SUM	1.637	-	0.374	0.022	1.263	N.A.	2.104	-0.022	0.623	-	-	1837
AVG	0.053	23	0.012	0.001	0.041	N.A.	0.068	-0.001	0.020	46	150	59
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SPACE HEATING SUBSYSTEM

SOLAR/1002-79/01

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	*	*	0.000	0.033	*	NOT	*	0.000	*	71	24
2	*	*	0.000	0.028	*		*	0.000	*	71	28
3	*	*	-0.010	0.028	*		*	0.000	*	72	31
4	0.347	13	0.045	0.022	0.302		0.504	0.000	0.075	73	33
5	0.388	16	0.061	0.017	0.327		0.545	0.000	0.102	73	31
6	0.342	23	0.061	0.013	0.265		0.445	0.000	0.129	72	34
7	0.382	26	0.077	0.014	0.284		0.473	0.000	0.165	71	36
8	0.295	18	0.053	0.012	0.242		0.403	0.000	0.088	73	37
9	0.411	19	0.080	0.026	0.331		0.552	0.000	0.133	71	38
10	0.380	-8	-0.030	0.020	0.410		0.684	0.000	-0.050	71	37
11	0.347	-11	-0.039	0.030	0.385		0.642	0.000	-0.065	72	40
12	0.328	-12	-0.007	0.016	0.335		0.559	0.000	-0.012	72	41
13	0.163	11	0.018	0.008	0.145		0.241	0.000	0.030	71	40
14	0.415	17	0.072	0.016	0.344		0.573	0.000	0.119	71	37
15	0.339	-5	-0.016	0.017	0.355		0.591	0.000	-0.026	69	36
16	0.357	-9	-0.031	0.019	0.388		0.647	0.000	-0.052	71	38
17	0.229	-7	-0.017	0.011	0.245		0.408	0.000	-0.028	74	39
18	0.203	35	0.072	0.006	0.131		0.219	0.000	0.119	69	37
19	0.271	29	0.078	0.010	0.194		0.323	0.000	0.129	67	42
20	0.196	10	0.020	0.010	0.176		0.294	0.000	0.033	67	46
21	0.203	9	0.019	0.010	0.184		0.307	0.000	0.051	67	40
22	0.327	3	0.011	0.018	0.316		0.526	0.000	0.019	68	37
23	0.319	-4	-0.013	0.016	0.332		0.553	0.000	-0.021	69	38
24	0.245	4	0.011	0.011	0.235		0.392	0.000	0.018	68	37
25	0.372	3	0.011	0.016	0.361		0.601	0.000	0.019	68	34
26	0.381	-8	-0.030	0.020	0.411		0.686	0.000	-0.050	69	34
27	0.332	-8	-0.027	0.017	0.411		0.598	0.000	-0.045	70	37
28	0.304	7	0.021	0.015	0.283		0.472	0.000	0.035	70	32
29	0.384	11	0.041	0.016	0.343		0.572	0.000	0.068	71	32
30	0.388	25	0.097	0.012	0.290		0.484	0.000	0.162	71	32
31	0.398	28	0.112	0.012	0.286		0.477	0.000	0.187	71	30
SUM	10.017	-	0.778	0.518	9.145	N.A.	15.242	0.000	1.454	-	-
AVG	0.323	9	0.025	0.017	0.295	N.A.	0.492	0.000	0.047	70	36
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SCLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SPACE COOLING SUBSYSTEM

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SOLAR/1002-79/01

DAY OF MON.	SPACE COOLING LOAD MILLION BTU	SOLAR FR. OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG DRY BULB TEMP F	AMB TEMP DEG F
1	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	24
2	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	28
3	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	72	31
4	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	73	33
5	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	73	31
6	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	72	34
7	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	36
8	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	73	37
9	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	38
10	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	37
11	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	72	40
12	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	72	41
13	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	40
14	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	37
15	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	69	36
16	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	38
17	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	74	39
18	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	69	37
19	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	67	42
20	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	67	46
21	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	67	40
22	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	68	37
23	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	69	38
24	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	69	37
25	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	68	34
26	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	69	34
27	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	70	37
28	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	70	32
29	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	32
30	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	32
31	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	NOT	71	30
SUM	N.A.	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	-	-
AVG	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	70	36
NBS	Q502	N500	Q500	Q503	Q501		Q508	Q512	Q514	N406	N113

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARYSITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SD-AR/1002-79/01

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	118	N O T	24	28	N O T	N O T	N O T
2	166		28	31 *			
3	224		31	38			
4	1372		33	37			
5	1404		31	40			
6	1379		34	42			
7	975		36	42			
8	1074		37	39 *			
9	191		38	40			
10	39		37	42			
11	12		40	42			
12	1152		41	43			
13	40		40	39			
14	184		37	37			
15	115		36	40			
16	1301		38	44			
17	1224		39	39			
18	9		37	42			
19	120		46	50			
20	513		40	40			
21	405		37	39			
22	313		38	41			
23	502		37	40			
24	416		34	38			
25	49		34	35			
26	173		37	38			
27	687		32	33			
28	1332		32	36			
29	1456		32	36			
30	1373		30	34			
31							
SUM	18332	N.A.	-	-	-	-	-
AVG	591	N.A.	36	39	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.

@ DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT THERMODYNAMIC CONVERSION EQUIPMENT

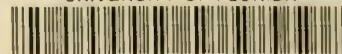
SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: JANUARY, 1979

SOLAR/1002-79/01

DAY OF MONTH	EQUIPMENT LOAD MILLION BTU	THERMAL ENERGY INPUT MILLION BTU	OPERATING ENERGY MILLION BTU	ENERGY REJECTED MILLION BTU	COEFFICIENT OF PERFORMANCE (SEE NOTE)
1	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
SUM	*	*	*	*	*
AVG	*	*	*	*	*

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.
NOTE:

UNIVERSITY OF FLORIDA



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